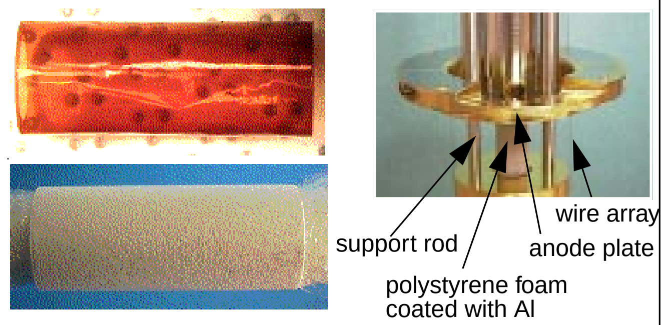
June 1997 Highlights of the Pulsed Power Inertial Confinement Fusion Program



8-mm-dia deuterated carbon-based foil (shots 83 and 86) and polystyrene foam (shots 84 and 85) to evaluate dynamic hohlraum. General Atomics fabricated foil cylinders and Schafer fabricated foam cylinders. Bubbles in top photo are images of material on which foil rests. Cylinders are coated with thin Al layer. At far right is coated cylinder inside 30-mm-dia, 180 W wire array, with hardware in oriented as installed. Support rods are removed prior to shot.

With the success in meeting and exceeding the first three PBFA Z milestones (150 TW and 1.5 MJ in radiated power and energy and 100 eV in a hohlraum), the facility has been renamed Z. The new name indicates our decision to continue using the facility in the z-pinch mode to create intense radiation sources for ICF, weapons physics, and weapons effects. A radiation temperature of 100 eV was first obtained in a static (non-imploding) hohlraum in early April. Since then, this result has been confirmed, and temperatures in excess of 100 eV have been obtained on other shots. This month we had our first external customers, LANL and the Defense Special Weapons Agency (DSWA).

We had 13 shots on Z: four to compare x-ray flux in an on-axis secondary hohlraum with that in an off-axis secondary, four to evaluate the reproducibility and the physics of imploding wires striking an annular foil or foam (see figures) for the dynamic (imploding) hohlraum concept, two LANL weapons physics shots with 300 tungsten wires in a 2-cm-dia, 1.5-cm-long array, two DSWA titanium wire array shots to develop a 5-keV K-shell radiation source for weapons effects testing, and a “graduated inductance shot” to assess the reduction of both load inductance and hohlraum area by tapering the return current can. The K-shell x ray yield for titanium DSWA shots is now 130 kJ; the first shot, in May, gave 90 kJ, which was already a world record. Beginning June 27, Z is down for two weeks to replace wheels on the overhead crane. The DSWA shots will then continue, followed by temperature measurements in static hohlraums of smaller diameter (2.4 - 2.6 cm) and smaller length (1.0 - 1.5 cm) than in April, where the diameter was 4 cm and the length 2 cm.

A 100-eV albedo-corrected temperature, assuming no hole closure, was first obtained in a large-volume hohlraum on Shot 53. The Z hardware is similar to that used to validate radiated power and energy scaling, except that the slotted return current can was replaced by a 4-cm-dia solid can coated inside with 25 µm of gold. The hohlraum behavior is imaged at the end of ~ 20-m-long line of sight pipes via diagnostic holes in the solid can at different azimuthal locations. On a large number of shots with a slotted can, the large format pinhole camera data suggest hole closure in the 200-eV energy band of the camera. The cause is believed to be a cold, strongly-absorbing plasma moving in during the pinch from the walls of the slotted can, *well before the pinch stagnates on axis*, that partially blocks the view of the hot, imploding wire plasma. To minimize hole closure we will tamp all diagnostic holes.

High-velocity, large-diameter z-pinch implosions are susceptible to magnetic Rayleigh-Taylor instability. This instability can degrade the pinch, leading to nonuniform implosions and reduced hohlraum temperatures, and is of greater importance to imploding as opposed to static hohlraums. We are studying the role of the instability with three 2D codes: the arbitrary-Lagrangian-Eulerian (ALE) magnetohydrodynamics (MHD) code MACH2, an MHD version of the Lagrangian code LASNEX with multigroup radiative transport, and a LANL 3-temperature, MHD Eulerian code. A 3D multigroup MHD code, ALEGRA, is being developed and tested, as well as a 2D version of ALEGRA. Eventually, we will be able to simulate the z-pinch implosion and transport of x rays in the hohlraum with 3D ALEGRA using the new massively-parallel Sandia/INTEL computer. An important ALEGRA property is its unstructured computational mesh, which is not limited to a system of rectangular meshes joined edge to edge, with corners meeting only at corners, as in the ALE code MACH2. This will allow the calculation of an imploding hohlraum that contains a capsule.

A new magnetic insulation parameter has been derived to determine where electrons are lost in an ion diode because of electromagnetic-instability-induced fluctuations. This theoretical parameter, P_{crit}, should be helpful in determining the proper location within the diode for electron limiters and for the reflective copper cone that will be used on axis to provide uniform laser illumination of the anode surface for the active Laser Evaporation Ion Source (LEVIS).

CD-3 (construction start) for the National Ignition Facility was approved in early March. In late June, a 33% Title-II design review that included the NIF-funded power conditioning system was held at LANL.

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